Check List the journal of biodiversity data

NOTES ON GEOGRAPHIC DISTRIBUTION

Check List 19 (6): 1021–1027
https://doi.org/10.15560/19.6.1021

PENSOFT

Range extension and the northern limit of the Chilean endemic *Anabittacus iridipennis* Kimmins, 1929 (Mecoptera, Bittacidae), with an updated distribution and biological notes

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Abstract. Chile has six species of Mecoptera, among which is *Anabittacus iridipennis* Kimmins, 1929. The genus *Anabittacus* Kimmins, 1929 (family Bittacidae) is monotypic and highly endemic to the southern part of the country. Here, we report two new localities for the rare *A. iridipennis* in southern Chile, specifically in the Los Ríos Region. Our new data extend the northern geographical limits of this species from the locality type. We provide a detailed diagnosis of this species and notes about the biology and the habitat of this enigmatic species.

Keywords. *Bittacus*, hanging flies, Los Ríos, southern Chile, Valdivian Forest

Academic editor: Renato Jose Pires Machado
Received 15 September 2023, accepted 13 November 2023, published 15 December 2023

Barahona-Segovia RM, Chinga J, Hepp J (2023) Range extension and the northern limit of the Chilean endemic *Anabittacus iridipennis* Kimmins, 1929 (Mecoptera, Bittacidae), with an updated distribution and biological notes. Check List 19 (6): 1021–1027. https://doi.org/10.15560/19.6.1021

Introduction

Hangingflies (Bittacidae) are the most diverse family of Mecoptera in the Neotropical realm with 72 valid species grouped into seven genera: *Anabittacus* Kimmins, 1929 (one species; Kimmins 1929); *Bittacus* Latreille, 1805 (40 species; Machado et al. 2009, 2018; Machado 2019); *Eremobittacus* Byers, 1997 (two species; Byers 2011); *Issikiella* Byers, 1972 (five species; Machado et al. 2009); *Kalobittacus* Esben-Petersen, 1914 (nine species; Rodríguez-Rojas 2016); *Nannobittacus* Esben-Petersen, 1927 (five species; Byers and Roggero 1992), and *Pazius* Navás, 1913 (10 species; Lima and Dias 2016). Bittacidae are predators of mainly of soft-bodied insects such as flies or aphids, but bittacids also feed on like spiders, pollen, fruit juices, and probably carrion (Byers and Thornhill 1983; Machado et al. 2022). Hangingflies inhabit mainly forest ecosystems where they are associated with the understory and where the females drop their eggs on litter (Byers and Thornhill 1983).

Anabittacus is monotypic and is the most enigmatic genus of the family Bittacidae in the Neotropics. The sole species, *A. iridipennis* Kimmins, 1929, was at one time phylogenetically placed at the base of the evolution within the family (Penny 1975). Recently, new evidence of this basal position of *A. iridipennis* among extant Bittacidae was given by Bashkuev (2023), which included on tarsal armament and wing venation, as well as male and female terminalia; Bashkuev (2023) positioned the species close to the fossil genera *Antiquanabittacus* Petrulevičius & Jarzembowski, 2004 and *Liaobittacus* Ren, 1993.

Anabittacus iridipennis has been scarcely collected since its original description, and confirmed individuals are restricted to several localities in the Los Lagos Region of southern Chile (Kimmins 1929; Machado et al. 2009). The biology and ecology of this species are unknown. Here, we extend the geographic range of *A.*

iridipennis northward in the Los Ríos Region. We also provide an updated range map and notes on the biology and habitat of this species.

Methods

We collected individuals of hangingflies at three new localities: Valdivia Province (39°48′51″S, 073°14′45″ W), Ancud, Chiloé Province (41°54′11.23″S, 073°54′ 32.68″W), and Fiordo Comau, Palena Province (42°28′ 20.75″S, 072°22′44.66″W); all sampling was conducted during the austral summers of 2020 and 2023. All localities have a temperate climate with high precipitation and low temperatures in fall and winter, and a dry summer, especially during January and February. The native forest in Valdivia Province is comprised of *Nothofagus* Blume spp. (Nothofagaceae), *Myrceugenia* O.Berg and *Luma apiculata* (DC) Burret (Myrtaceae), together with *Aextoxicum punctatum* Ruiz & Pav. (Aextoxicaceae) and *Embothrium coccineum* J.R.Forst. & G.Forst. (Proteaceae). The native forests in Ancud have a similar in composition to the forests in Valdivia Province. On the other hand, in Caleta Porcelana, the dominant trees are *Nothofagus dombeyi* (Mirb.) Oerst., *Myrceugenia planipes* (Hook. & Arn.) O.Berg, *L. apiculata*, and *Drimys winteri* J.R.Forst. & G.Forst. (Winteraceae). In both localities, the forest has a developed understory with *Aristotelia chilensis* (Molina) Stuntz (Elaeocarpaceae) and several *Chusquea* Kunth spp. (Poaceae).

Hangingfly individuals were collected by hand after beating the understory using an entomological umbrella. The samples were stored in 90% alcohol in the entomological collection of the Universidad de Los Lagos (ULA, Osorno, Chile). Photographs of the live hangingflies were taken with an Olympus OM-D E M5 Mark III camera with a 60 mm macro lens, while the dead insect was photographed with a Sony A6600 with a Laowa 65mm 2× lens and Meike flashes. The distribution map was constructed from records in the literature and specimens from the following museums: Essig Museum of Entomology, University of California, Berkeley, California, USA (EMEC) via in GBIF (Gross and Oboyski 2023); the Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil (INPA); Museo de Zoología of the Universidad de Concepción, Chile (MZUC); Natural History Museum, London, UK (NHMUK) via in GBIF (Natural History Museum 2023); National Museum of South Africa arthropod collection (NMSA) via in GBIF (Muller and Ranwashe 2017); Universidad de Los Lagos entomological collection, Osorno, Chile (ULA); and National Museum of Natural History, Smithsonian Institution, Washington DC, USA (USNM) via in GBIF (Orrell and IDSC 2023; Orrell and Informatic Office 2023). The extant of occurrence (EOO) and area of occupancy (AOO) were determined with "ConR" (Dauby et al. 2017) using R v.2022.07.2 software (R Development Core Team 2022). The distribution map was created with QGis v. 3.32.2 (QGIS Development team 2022).

We used the original description of Kimmins (1929) to initially identify the collected individuals. We verified our determination using the keys by Penny and Byers (1979) and Machado et al. (2009). The terminology used in the identification section follows Machado et al. (2018) and Zhang et al. (2020).

Results

Order Mecoptera Hyatt & Arms, 1891
Family Bittacidae Handlirsch, 1906

Genus *Anabittacus* Kimmins, 1929

Kimmins 1929: 192 (original description); Smithers 1973: 300 (Australian Mecoptera); Penny 1975: 341 (evolution), fig. 6B (wing); Penny and Byers 1979: 363 (key), figs. 1–5 (male terminalia); Byers and Thornbill 1983: 204 (biology); Petrulevičius 2003: 258 (systematic paleontology); Petrulevičius and Jarzembowski 2004: 1197 (systematic paleontology); Petrulevičius et al. 2007: 146 (systematic paleontology); Machado et al. 2009: 36 (checklist); Tan and Hua 2009: 28 (key); Hünefeld and Beutel 2012: 235 (biology of *Nannochorista*); Yang et al. 2012: 200 (systematic paleontology).

Anabittacus iridipennis Kimmins, 1929

Figures 1A–F, 2A, B

Kimmins 1929: 192 (description); Byers 1965: 136 (male terminalia), figs. 1–5 (male, terminalia); Penny and Byers 1979a: 363 (key); Penny and Byers 1979b: 366 (checklist); Machado et al. 2009: 36 (checklist); Bashkuev 2023: 1 (description and comparison with fossil Mecoptera).

New records. CHILE – **Valdivia** • Valdivia, Parque Oncol; 39°42′10″S, 073°18′21″W; 537 m a.s.l.; 12.I.2020; R. Barahona-Segovia leg.; caught by hand; 1 ♀, MEC 001/ULA • Corral, Reserva Costera Valdiviana; 39°59′ 42″S, 073°34′40″W; 362 m a.s.l.; 13.I.2007; Elizabeth Arias leg.; 1 sex indet., EMEC106575 • same locality; 39°59′42″S, 073°34′40″ W; 362 m a.s.l.; 13.I.2007; Elizabeth Arias leg.; 1 sex indet., EMEC106576 – **Llanquihue** • Pargua; [41°47′S, 073°27′W, 20 m a.s.l.]; 30.XI. 1966; J. Solervicens leg.; sex indet., MZUC – **Chiloé** • Ancud, Agrosol; 41°54′11″S, 073°54′32″W, 148 m a.s.l.; 18.I.2017; Rodrigo Barahona-Segovia leg.; caught by hand; 1 ♀, MEC002/ULA • Ancud, Chepu; 42°02′34″ S, 074°00′30″W; 33 m a.s.l.; 12.II.2021; Ricardo Varela Leg.; sex indet., photograph only – **Palena** • Río Vodudahue, Placeta, Caleta Porcelana; 42°28′20″S, 072°22′ 44″W; 256 m a.s.l.; 9.I.2017; Rodrigo Barahona-Segovia, Javiera Chinga & Josefina Hepp leg.; caught by hand; 1 ♀, MEC003/ULA (Fig. 2).

Other specimens. CHILE – **Osorno** • Puyehue National Park, Aguas Calientes; 40°44′07″S, 072°18′42″W; 5.XII.1987; 496 m a.s.l.; B.R. Stuckenberg leg.; 1 sex indet., NMSA-Mec975 – **Llanquihue** • Puerto Varas, 3 km NW of Ensenada; 41°10′59″S, 072°31′59″W; 92 m a.s.l.; 29.I.1998; N. Woodley leg.; GeneBank MN345193; 1 sex indet., USNMENT01639692.1 • same locality; 41°10′59″S, 072°31′59″W; 92 m a.s.l.; 29.I.1998; N.

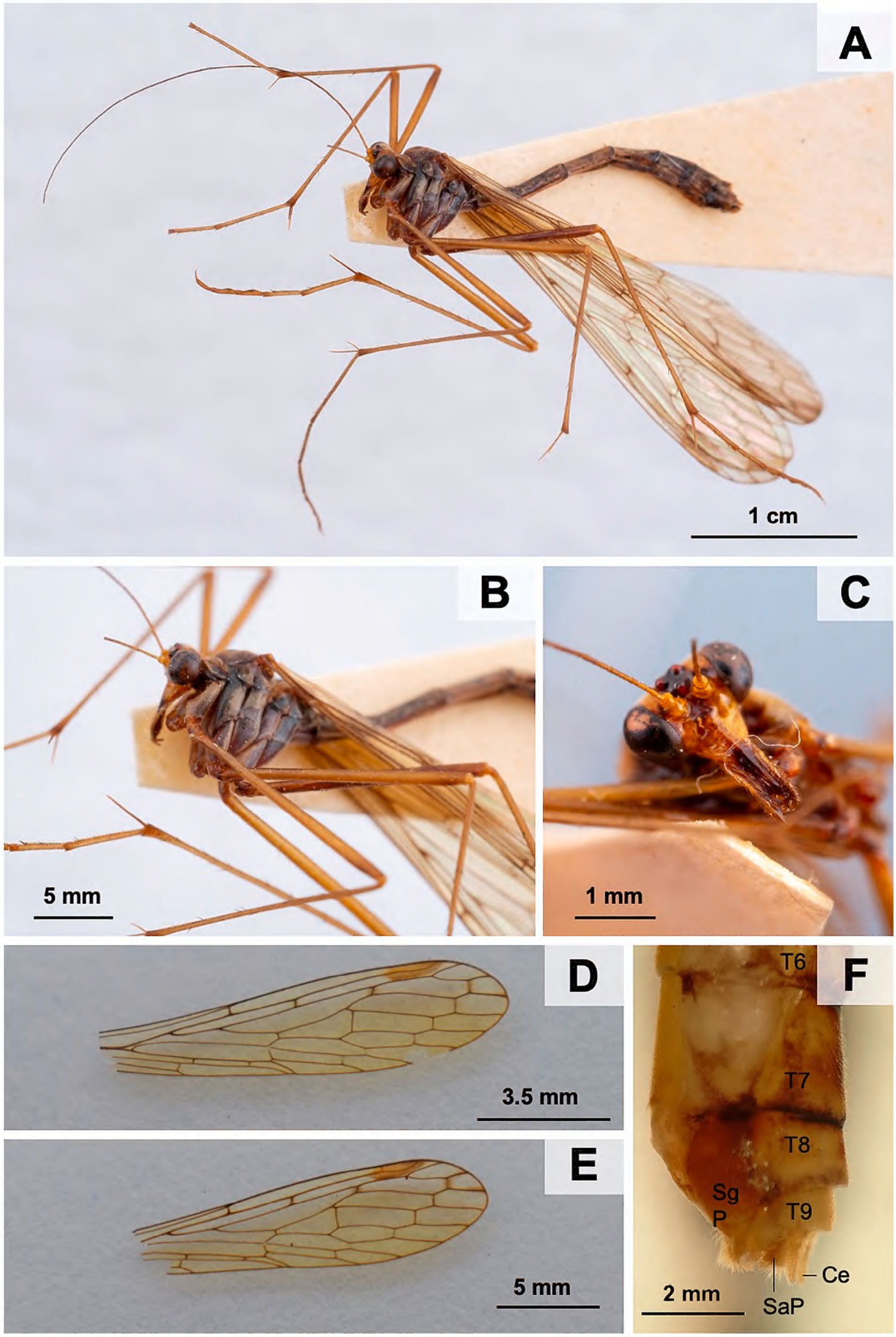

Figure 1. *Anabittacus iridipennis* Kimmins, 1929. **A.** Lateral view. **B.** Details of thoracic segments and legs, lateral view. **C.** Details of the head, frontal view. **D.** Fore wing. **E.** Hind wing. **F.** Female terminalia. Ce = Cercus; SaP = subanal plate; SgP = subgenital plate; T(number) = tergites.

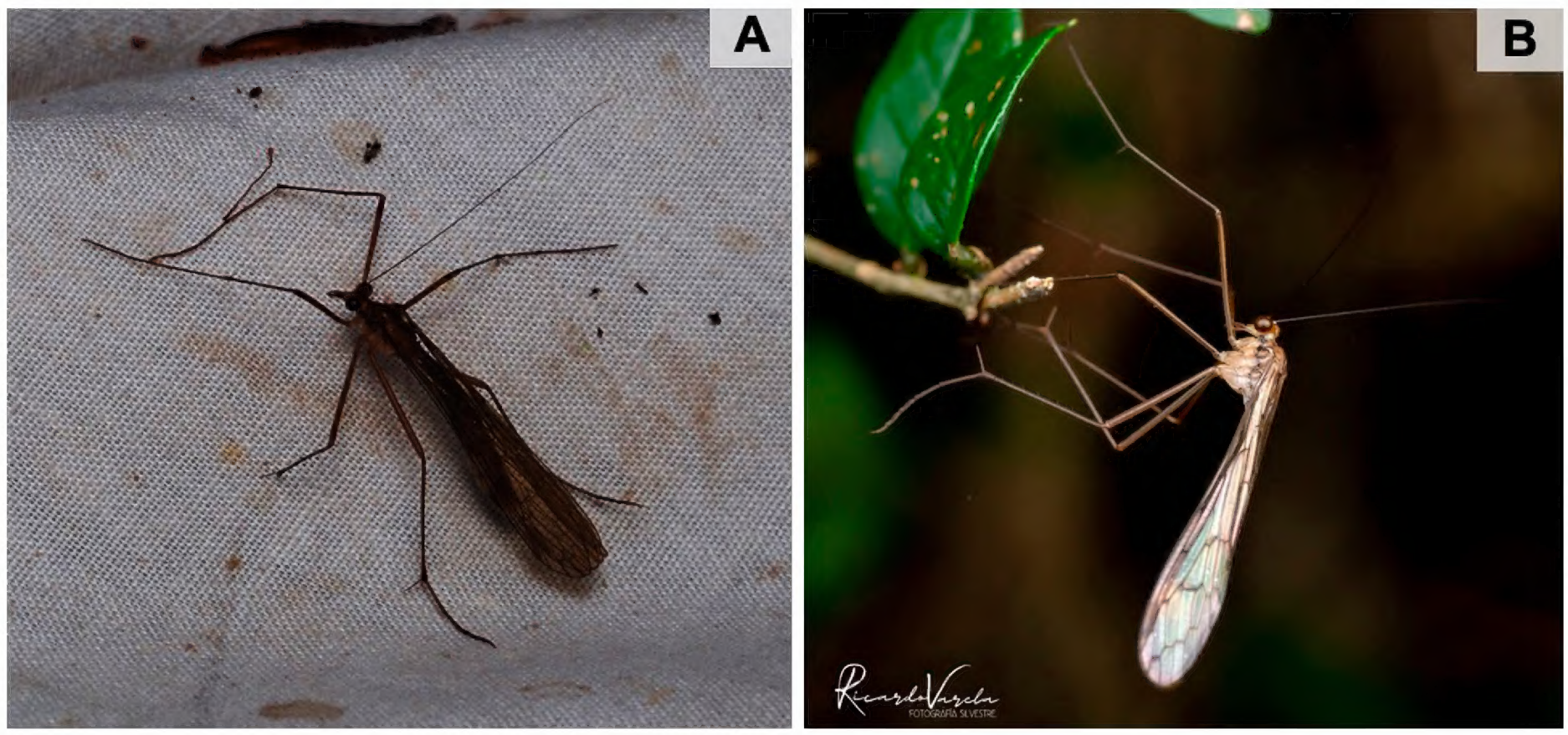

Figure 2. Living *Anabittacus iridipennis* Kimmins, 1929. **A.** Specimen of Palena Province on *Chusquea* spp. (photo by Javiera Chinga). **B.** Specimen from Chepu, Chiloé (photo by Ricardo Varela-Varela).

Woodley leg.; 1 sex indet., USNMENT01454480 • Llanquihue, Peulla; [41°05′S, 072°00′W;; 323 m a.s.l.]; 12–13.XII.1926; F. & M. Edwards leg.; 1 sex indet., record 686039, NHMUK • Llanquihue, Casa Pangue; [41°2′S, 71°52′W; 387 m a.s.l.]; 4–10.XII.1926; F. & M. Edwards leg.; 1sex indet., NHMUK010729837 • Lago Chapo, Hornohuinco; [41°24′S, 072°38′W; 369 m a.s.l.]; 1 sex indet., INPA • Alerce Andino National Park; [41°34′S, 072°32′W]; 10–11.I.2014; E. Lukashevich & D. Sherbakov leg. – **Chiloé** • Huillinco, Puente La Caldera; 42°40′01″S, 074°00′48″W; 16 m a.s.l.; 26.XII.1993; C. Flint & O. Flint leg.; GeneBank MN346030; 1 sex indet., USNMENT01454479 • same locality; 42°40′01″S, 074°00′48″W; 16 m a.s.l.; 26.XII.1993; C. Flint & O. Flint leg.; 1sex indet., USNMENT01639691.1 • 11km SE of Chonchi, on road to Queilen; 42°37′12″S,0 73°46′36″W; 8.XII.1987; B.R. Stuckenberg leg.; 1 sex indet., NMSA-Mec972; 1 sex indet., NMSA-Mec973; 1 sex indet., NMSA-Mec974.

Diagnoses. *Anabittacus iridipennis* is the only species in its genus. According to Kimmins (1929), Penny and Byers (1979), and Machado et al. (2009), this species can be differentiated from those in other bittacid genera because vein M_4 in the forewing arises at the first fork of M and cross veins of pterostigma are absent (Figs. 2D). Here we redescribed this species based on the diagnosis provided by Kimmins (1929) and our collected specimens.

Redescription. Head reddish-brown; ocellar triangle black, with three prominent red ocelli. Antennae reddish-brown and as long as forewings (Fig. 1C). Scape wider than pedicel; first flagellomere longer than scape and pedicel combined. Each flagellomere with short, darkish setae. Both the labrum and the distal part of the maxillary and labial palps are brownish, with many brownish setae. Eyes darkish (Fig. 1C).

Pronotum, mesonotum, and metanotum reddish-brown with a black medial stripe along the length of thorax and reaching posterior margin of scutellum (Fig. 2A). Pleura unevenly pale yellowish, with a black stripe running entire length (Figs. 1A, 2A). Femora brownish-yellow (Figs. 1B, C, 2B). Tibiae brownish, with 5–11 setae sparsely distributed on lateral side, and with two strong tibial spurs on distal part (Figs. 1B, C, 2A, B). Tarsi brownish. First tarsomere of the fore legs twice length of first tarsomere of hind legs, and with some black setae (Figs. 1A–C). First tarsomeres of mid- and hind legs ¼ longer than the second tarsomere (Figs. 1B, C, 2A–B). Hyaline wings with pterostigma at apex of cell r1 and near apices of cell r2 and without cross-vein near the apex of vein R_1 (Fig. 1D). Subcostal cross-vein of hind wing extends slightly beyond fork of radial sector; fork of M far beyond that.

Abdomen reddish-brown and twice as long as thorax. Tergites pale brownish-yellow with anterior margins blackish and medial black stripe (Fig. 1A, 1F). Sternites pale yellow, without black marks. Abdominal segments in older individuals brownish (Figs. 1B, C). Female terminalia with 9th tergite, cercus, and subanal plate yellowish, covered of dozens of fine, yellowish piles. Cerci slightly longer than subanal plate. Subgenital plate reddish, equal in length to subanal plate.

Biological notes. *Anabittacus iridipennis* inhabit native forests with trees approximately 20–30 m high. These native forests cooler than in the matrix and along unforested roads, and they present a well-developed understory with high structural complexity. Plant species such as *Ugni molinae* Turcz., *Aristotelia chilensis* (Molina) Stuntz and *Chusquea* spp. are characteristic of the understory inhabited by *A. iridipennis*. The forest floor is completely covered by leaf litter. An individual of *A. iridipennis* was observed feeding on a female of *Dilophus* sp. (Bibionidae) at midday in Los Ríos Region. A couple of individuals (not captured) were observed mating in a *Myrceugenia* sp. near the forest floor.

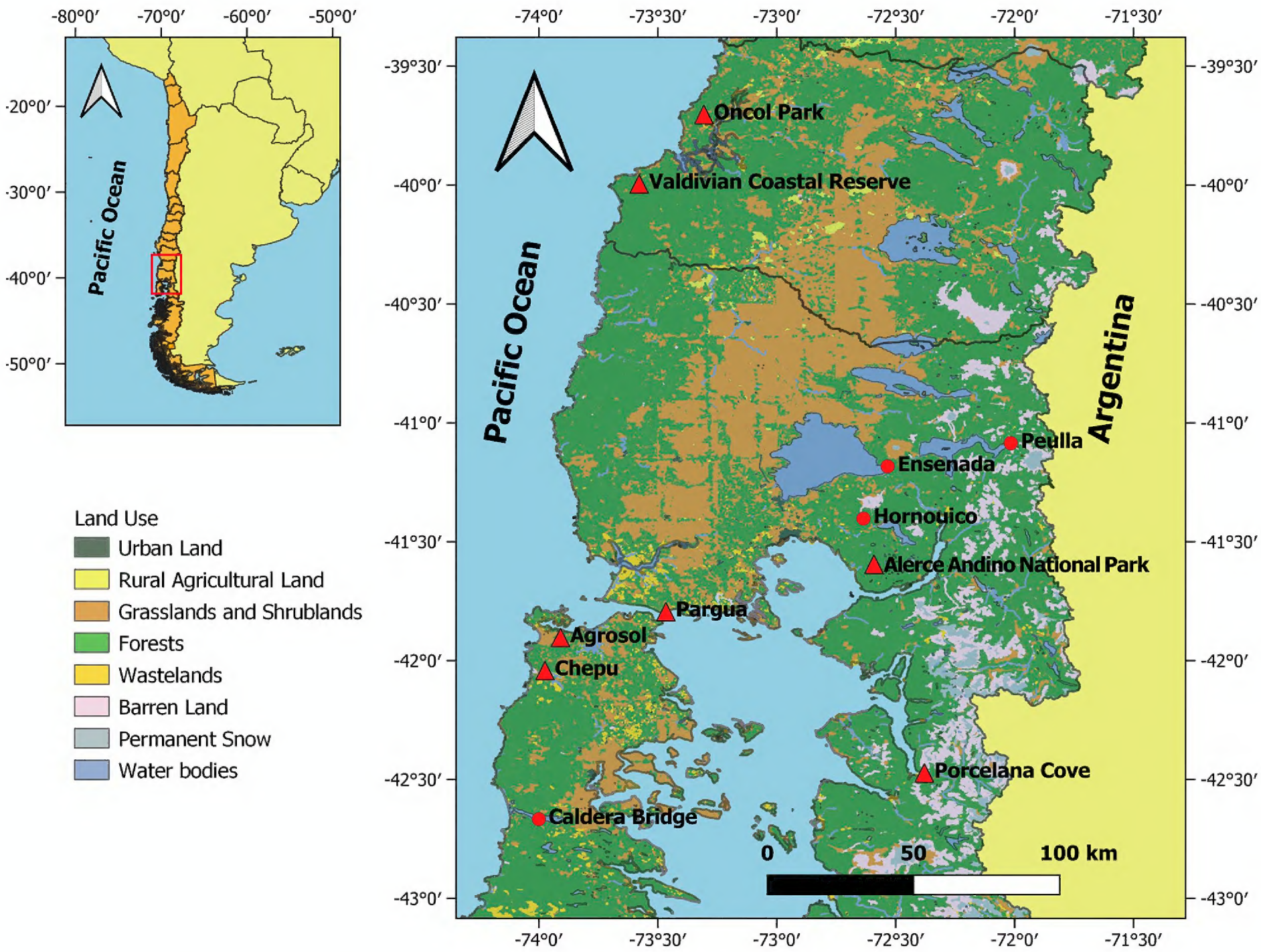

Figure 3. Distribution map of *Anabittacus iridipennis* Kimmins, 1929 and collection localities. Red dots = historical records, red triangles = new records.

Distribution. The species is endemic to Chile and restricted to the Los Ríos and Los Lagos regions. The EOO was calculated as 37,412 km^2, and AOO is 48 km^2. There are 12 subpopulations known (Fig. 3).

Discussion

The geographic range of *A. iridipennis* is extended 189 km northwest from the type locality at Peulla to Oncol Park in the Los Ríos Region (Fig. 3). The new records of this hangingfly species in the Valdivian Forest represent the northernmost limits of this species; however, *A. iridipennis* may occur farther to the north, as do other taxa of Valdivian origin such as rodents and marsupials (Saavedra and Simonetti 2001), giant leeches, snails (Barahona-Segovia et al. 2019, 2021), frogs (Cuevas & Cifuentes 2011), and bats (Rodríguez-San Pedro et al. 2015). In fact, Byers (1965) mentioned other northern localities as Enco (Los Ríos Region) or Palo Botado (Biobío Region), but all of these records are unconfirmed because repository information is not available. Interestingly *A. iridipennis* has not been recorded in the Valdivian Forest in the coastal range between these new northern limits and Pargua (approximately 200 km in straight line); this coastal range retains large patches of native forest. There is a possibility that *A. iridipennis* might also occur *Nothofagus* forests in Argentina. Additional specimens could bring us better ecological data to support the modeling of this species' distribution and fill the spatial gaps in the distribution of this scarce mecopteran.

The biology and ecology of many hangingfly species are unknown (Byers and Thornhill 1983). *Anabittacus iridipennis* is not a very abundant mecopteran, and the few specimens collected have been caught in Malaise traps or by hand in the understory. Not only does this habitat offer a high diversity and availability of soft-bodied insects as prey, but it is also a suitable place to find a mate, breed, and lay eggs. A single specimen was collected in Palena Province in *Nothofagus* forest having an understory of Chilean bamboo (*Chusquea* spp.) where this specimen was observed waiting for flying soft-bodied insects. In Chiloé, two other *A. iridipennis* (not captured) were observed mating and hanging from a branch of *Myrceugenia* sp. near the ground. According to Byers and Thornhill (1983), leaf litter the likely place that eggs are deposited, although it seems that the development of the eggs and larvae would depend on the ambient temperatures. A third individual (collected) was feeding on a *Dilophus* (Bibionidae) on a juvenile *Myrceugenia* sp. in Parque Oncol. In all cases, the individuals collected or observed were using the understory.

More field studies on *A. iridipennis* are required to better understand how in the understory influences this species' abundance and occurrence.

Acknowledgements

We are grateful to the Fundación Chilco and Fundación Alerce 3000 (http://www.fundacionalerce3000.cl) for providing access to and the logistics of carrying out our study in Vodudahue Reserve. We also thank Esteban Gallardo for his help with the distribution map and Ricardo Varela-Varela for photographing specimens in the lab. Finally, we thank to our reviewers, Wesley Bicha and Adrian Gómez-Jácome, as well as to our editors Renato José Pires Machado and Robert Forsyth for your comments and suggestions. Rodrigo Barahona-Segovia thanks to ANID-SIA grant no. 85220045.

Author Contributions

Conceptualization: RMB-S. Data curation: RMB-S. Formal analysis: RMB-S. Funding acquisition: RMBS, JH. Investigation: RMB-S, JC, JH. Methodology: RMB-S, JC, JH. Project administration: JH. Resources: JH. Validation: RMB-S. Visualization: JC, JH. Writing – original draft: RMB-S. Writing – review and editing: RMB-S, JC, JH.

References

Barahona-Segovia RM, Alaniz AJ, Durán-Sanzana V, Flores Flores E, Gerstle J, Montecinos-Ibarra R, Pérez-Schultheiss J, Rabanal FE, Reyes D, Ramos V, Venegas-Díaz C, Weymann M, Smith-Ramírez C, Araya JF, Vergara PM (2021) Combining citizen science with spatial analysis at local and biogeographical scales for the conservation of a large-size endemic invertebrate in temperate forests. Forest Ecology and Management 497: 119519. https://doi.org/10.1016/j.foreco.2021.119519

Barahona-Segovia RM, Riveros-Díaz AL, Zaror S, Catalán R, Araya JF (2019) Shelter, ecophysiology and conservation status of *Plectostylus araucanus* (Pulmonata: Bothriembryontidae) in the fragmented Maulino Forest, central Chile. Revista Mexicana de Biodiversidad 90: e902703. https://doi.org/10.22201/ib.20078706e.2019.90.2703

Bashkuev AS (2023) Morphology and relationships of the bittacid genus *Antiquanabittacus* Petrulevičius et Jarzembowski, 2004 (Mecoptera), with description of three new species from the Lower Cretaceous of south-east Siberia. Cretaceous Research 148: 105549. https://doi.org/10.1016/j.cretres.2023.105549

Byers GW (1965) New and uncommon neotropical Mecoptera. Journal of the Kansas Entomological Society 38 (2): 135–144.

Byers GW (1972) A new genus of Mecoptera from Brazil. Journal of the Kansas Entomological Society 45 (3): 341–346.

Byers GW (1997) Four puzzling new species of Mecoptera. Proceedings of the Entomological Society of Washington 99 (4): 681–692.

Byers GW (2011) Additions to the Mecoptera of Mexico. Journal of the Kansas Entomological Society 84: 1–11. https://doi.org/10.2317/jkes080923.1

Byers GW, Roggero RJ (1992) Hanging-flies of Panama (Mecoptera: Bittacidae). In: Quintero D, Aiello A (Eds.) Insects of Panama and Mesoamerica: selected studies. Oxford University Press, Oxford, UK, 594–599.

Byers GW, Thornhill R (1983) Biology of the Mecoptera. Annual Review of Entomology 28 (1): 203–228. https://doi.org/10.1146/annurev.en.28.010183.001223

Cuevas C, Cifuentes S (2010) Amphibia, Anura, Ceratophryidae, *Batrachyla leptopus* Bell, 1843: new records updating and geographic distribution map, Chile. Check List 6 (4): 633–636. https://doi.org/10.15560/6.4.633

Dauby G, Stévart T, Droissart V, Cosiaux A, Deblauwe V, Simo-Droissart M, Sosef MSM, Lowry II PP, Schatz GE, Gereau RE, Couvreur TLP (2017) ConR: an R package to assist large-scale multispecies preliminary conservation assessments using distribution data. Ecology and Evolution 7: 11292–11303. https://doi.org/10.1002/ece3.3704

Esben–Petersen P (1914) New genera and species of Mecoptera. Entomologiske Meddelelser 10: 129–132.

Esben-Petersen P (1927) New and little-known species of Mecoptera and Neuroptera in the Zoological Museum of Helsingfors. Notulae Entomologicae 7:13–18.

Gross J, Oboyski P (2023) Occurrence dataset https://www.gbif.org/occurrence/1060881610. Essig Museum of Entomology. Version 121.313. Accessed on: 2023-11-07. https://doi.org/10.15468/0saucj

Kimmins DE (1929) Some new and little known Argentine Neuroptera. Revista de la Sociedad Entomológica Argentina 2: 187–192.

Latreille PA (1805) Histoire naturelle, générale et particulière de crustacés et des insectes. Vol. 13. Dufart, Paris, 432 pp. https://doi.org/10.5962/bhl.title.15764

Lima AR, Dias PG (2016) The uncommon Neotropical genus *Pazius* Navás, 1913 (Mecoptera: Bittacidae): a comprehensive synthesis, with description of a new Brazilian species. Zootaxa 4169 (3): 504–514. https://doi.org/10.11646/zootaxa.4169.3.5

Machado RJP (2019) One new species of hangingfly from Bolivia, *Bittacus vazdemelloi* sp. nov. (Mecoptera: Bittacidae), with an identification key to South American species of *Bittacus* Latreille. Austral Entomology 58 (4): 739–744. https://doi.org/10.1111/aen.12424

Machado RJP, Godoi FSP, Rafael JA (2009) Neotropical Mecoptera (Insecta): new generic synonymies, new combinations, key to families and genera, and checklist of species. Zootaxa 2148 (1): 27–38. https://doi.org/10.11646/zootaxa.2148.1.2

Machado RJP, De Mello Mendes DM, Rafael JA (2018) The genus *Bittacus* Latreille (Insecta: Mecoptera) in Brazil: key to species, distribution maps, new synonym, and three new species. Zootaxa 4526 (3): 303–330. https://doi.org/10.11646/zootaxa.4526.3.2

Machado RJP, Soares MMM, da Silva Carvalho-Filho F (2022) Updates on the Brazilian Hangingfly Species of the Genera *Issikiella* Byers, *Nannobittacus* Esben-Petersen, and *Pazius* Navás (Insecta: Mecoptera: Bittacidae). Neotropical Entomology 51 (5): 742–751. https://doi.org/10.1007/s13744-022-00989-0

Muller B, Ranwashe F (2017) Occurrence dataset, https://www.gbif.org/occurrence/1325711393. NMSA: arthropod collections (1900–2012), version 1.1, South African National Biodiversity Institute. Accessed on: 2023-08-16. https://doi.org/10.15468/a4tpcb

Hünefeld F, Beutel RG (2012) The female postabdomen of the enigmatic Nannochoristidae (Insecta: Mecopterida) and its phylogenetic significance. Acta Zoologica (Stockholm) 93: 231–238. https://doi.org/10.1111/j.1463-6395.2011.00551.x

Natural History Museum (2023) Occurrence dataset, https://www.gbif.org/occurrence/1826336602. Natural History Museum (London) Collection Specimens. Accessed on: 2023-11-07. https://doi.org/10.5519/qd.zqujp4ov

Orrell T, IDSC (Informatics and Data Science Center, Digital Stewardship Team) (2023) Occurrence dataset, https://www.gbif.org/occurrence/3028071265. NMNH Material Samples (USNM), version 1.55, National Museum of Natural History, Smithsonian Institution. Accessed on: 2023-08-16. https://doi.org/10.15468/jb9tdf

Orrell T, Informatics Office (2023) Occurrence dataset, https://www.gbif.org/occurrence/2986699304. NMNH Extant Specimen Records (USNM, US), version 1.71, National Museum of Natural History, Smithsonian Institution. Accessed on: 2023-08-16. https://doi.org/10.15468/hnhrg3

Penny ND (1975) Evolution of the extant Mecoptera. Journal of the Kansas Entomological Society 48: 331–350.

Penny ND, Byers GW (1979a) Chave para as famílias e gêneros da Mecoptera (Insecta) da América, do sul dos Estados Unidos. Acta Amazonica 9 (2): 363–364.

Penny ND, Byers GW (1979b) A check-list of the Mecoptera of the world. Acta Amazonica 9 (2): 365–388.

Petrulevičius JF (2003) Phylogenetic and biogeographical remarks on *Thyridates* (Mecoptera: Bittacidae), with the first fossil record of the taxon. Acta Zoologica Cracoviensia 46 (Supplement): 257–265.

Petrulevičius JF, Jarzembowski EA (2004) The first hangingfly (Insecta: Mecoptera: Bittacidae) from the Cretaceous of Europe. Journal of Paleontology 78 (6): 1198e1201. https://doi.org/10.1666/0022-3360(2004)078<1198:tfhimb>2.0.co

Petrulevičius JF, Huang DY, Ren D (2007) A new hangingfly (Insecta: Mecoptera: Bittacidae) from the Middle Jurassic of Inner Mongolia, China. African Invertebrates 48 (1): 145–152.

QGIS Development Team (2022) QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.

R Development Core Team (2022) R: a language and environment for statistical computing. Version 2022.07.22. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org. Accessed on: 2022-02-04.

Ren D (1993) First discovery of fossil bittacids from China. Acta Geologica Sinica 67 (4): 376e381.

Rodríguez-Rojas E (2016) Una nueva especie de *Kalobittacus* Esben-Petersen, 1914 (Mecoptera: Bittacidae) de Costa Rica. Brenesia 85–86: 61–64.

Rodríguez-San Pedro A, Barquez R, Simonetti J (2015) *Histiotus magellanicus* (Chiroptera: Vespertilionidae) is not restricted to Subantarctic forests: first record for the Coastal Maulino Forest in central Chile. Check List 11 (2): 1–3. https://doi.org/10.15560/11.2.1576

Saavedra B, Simonetti JA (2001) New records of *Dromiciops gliroides* (Microbiotheria: Microbiotheriidae) and *Geoxus valdivianus* (Rodentia: Muridae) in central Chile: their implications for biogeography and conservation. Mammalia (Paris) 65 (1): 96–100.

Smithers CN (1973) New species and records of Australian Bittacidae (Mecoptera). Australian Journal of Entomology 12 (4): 296–300.

Tan JL, Hua BZ (2009) *Bicaubittacus*, a new genus of the Oriental Bittacidae (Mecoptera) with descriptions of two new species. Zootaxa 2221 (1): 27–40. https://doi.org/10.11646/zootaxa.2221.1.2

Yang XG, Shih CK, Ren D, Petrulevičius JF (2012) New Middle Jurassic hangingflies (Insecta: Mecoptera) from Inner Mongolia, China. Alcheringa: an Australasian Journal of Palaeontology, 36 (2): 195–201. https://doi.org/10.1080/03115518.2012.622143

Zhang YN, Du W, Hua BZ (2020) Three new species of the genus *Bittacus* Latreille, 1805 (Mecoptera: Bittacidae), with a key to the species of Bittacidae in South China. Zootaxa 4718 (3): 381–390. https://doi.org/10.11646/zootaxa.4718.3.6